Louisiana State University
LSU Digital Commons

LSU Agricultural Experiment Station Reports | LSU AgCenter

1967

The five most serious diseases of Louisiana strawberries

Norman Lewis Horn

Follow this and additional works at: http://digitalcommons.lsu.edu/agexp

Recommended Citation
Horn, Norman Lewis, "The five most serious diseases of Louisiana strawberries" (1967). *LSU Agricultural Experiment Station Reports*. 828.
http://digitalcommons.lsu.edu/agexp/828

This Article is brought to you for free and open access by the LSU AgCenter at LSU Digital Commons. It has been accepted for inclusion in LSU Agricultural Experiment Station Reports by an authorized administrator of LSU Digital Commons. For more information, please contact gcoste1@lsu.edu.

S
67
E36

The Five Most Serious Diseases Of Louisiana Strawberries

N. L. Horn, R. B. Carver and R. G. Carver

LOUISIANA STATE UNIVERSITY
AND AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATION
DOYLE CHAMBERS, DIRECTOR

Bulletin No. 624

December 1967

CONTENTS

The Five Most Serious Diseases Of Louisiana Strawberries

LOUISIANA STATE UNIVERSITY LIBRARY

N. L. Horn, R. B. Carver and R. G. Carver

Plant Pathology Department

Introduction

The information in this publication has been obtained from experimental work with Louisiana strawberry varieties at the Louisiana State University Experiment Station at Baton Rouge, the substations at Hammond and Clinton, and at various growers' farms. The subject deals with the five most common and serious diseases of strawberries that occur in both home gardens and commercial plantings. The information presented herein was compiled to assist growers in gaining a better understanding of strawberry pathology, which is without a doubt the least understood of the sciences by those involved in the industry. For example, few growers know that a fungus is the causal agent of the leaf spot disease commonly known as "rust." The fungus is a microscopic plant which they have never seen, so naturally it would be a very mysterious thing to them. Likewise, nematodes are microscopic. Even the galls they form on strawberry roots are rather inconspicuous. Thus only a few growers have seen them, and then perhaps only when the galls were pointed out to them. More perplexing are the viruses, for there are no symptoms such as leaf spots or galls that indicate infection (except in the case of aster yellows virus); thus, the grower doesn't know that his plants are diseased. Even the researcher cannot detect the presence of virus unless special methods are employed.

The data compiled herein will assist those growers who are unaware of plant diseases or have certain misconceptions regarding them, and will also aid the more informed growers in improving their methods of disease control. Anyone who has ever grown strawberries is aware of disease problems, regardless of his knowledge of plant pathology. He knows that when berries rot in wet weather the yields are reduced, and he is concerned about it. But if the grower understands what actually causes the rot, and if he knows that a chemical applied to the plants will prevent the rot condition by killing the fungus, then it is much more likely that he will have a better attitude toward controlling the disease.

Leaf Spot

Every commercial grower knows that strawberry plants become infected with a leaf disease that locally is called "rust." However, many don't know that the disease is caused by a fungus *(Mycosphaerella*

fragariae). Furthermore, many don't realize that the spots formed on the leaves by the fungus cannot be made to disappear. Some growers have indicated that they expected the spots to vanish when fungicides were sprayed on the foliage. Therefore, in order to help clarify misconceptions that some farmers have about this leaf spot disease, the authors offer the following simplified description of the fungus and some information about the nature of the disease in relation to control.

Essentially, the fungus that causes leaf spot disease is a microscopic plant composed of a mass of strands or threads which grow in a localized area inside the leaf. It extends its growth in all directions as it feeds on the cell sap. As a result the cells die and a spot is formed (Fig. 1). Many spots on a strawberry leaf cause the plant to have a rusty appearance, and the leaf will die when a sufficient number of spots are formed. The fungus grows to the leaf surface in the center of the spots, forcing the leaf epidermis, or outer surface, to erupt. On short stalks spores, or "seeds," are produced in a somewhat sticky mass. Splashing rain can disseminate them to the same leaf and to surrounding plants. These spores are essentially like the seeds of flowering plants, for wherever a seed is planted a new plant will develop. Thus, wherever a spore falls the fungus grows into the leaf to form a new colony which ultimately causes a leaf spot. Thousands of spores are formed in each spot, so spread of the disease can be very rapid.

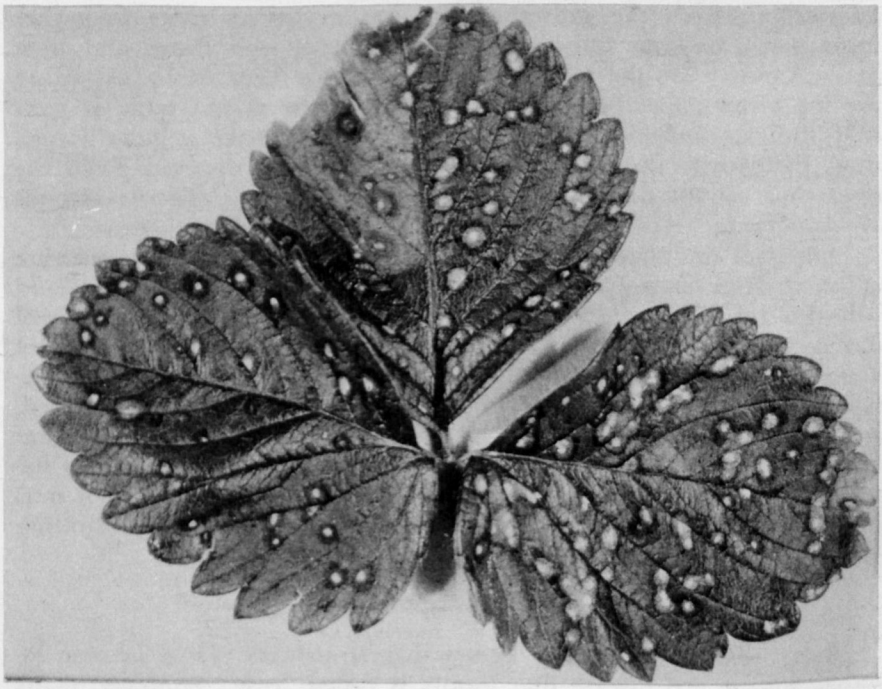

FIG. 1.—Strawberry leaf spot caused by Mycosphaerella fragariae on a Dabreak leaf.

Once the spot forms, which is dead leaf tissue, it cannot be made to disappear. Fungicides to control the leaf spot disease are applied to protect healthy foliage from spores that are splashed on them. The spray material is applied to the plants so that spores that fall on the leaf surface will be killed when they contact the fungicide. Of course it would be extremely difficult for a grower to cover every leaf surface completely, even with the best spray equipment. Therefore, one would expect some fungus spores to escape the fungicide, which means that some spots would be formed. One can readily see, then, that to insure the best protection from the fungus, a grower should establish a regular spray program for 12 months of the year.

Bluestone and lime (Bordeaux mixture) 4-4-100 or other copper fungicides, including "Copper A," "Tribasic copper sulfate," and "C.O.C.S.," have been recommended by the Louisiana State University Experiment Station as a control for leaf spot *(15)*[1]. The copper fungicides range from 25 to 55 per cent in their content, which is clearly cited on the packages. Those at the lower range should be mixed at the rate of 6 pounds in 100 gallons of water, whereas those at the upper range should be used at 3 pounds in 100 gallons of water.

The effect of the leaf spot disease on yields of berries (Table 1) was demonstrated by Plakidas *(15)* in 1930-1931 when the Klondike variety was grown extensively in Louisiana. This variety was very susceptible to leaf spot and had to be sprayed to insure good fruit yields.

Table 1.—Per acre yields of 24-pint crates of strawberries from sprayed and nonsprayed plants, 1930-1931

	1930	1931
Sprayed	274	348
Nonsprayed	167	129
Difference in favor of sprayed	107	219

Captan has also been shown to give good control of leaf spot. In a fungicide spray program for the control of fruit rot from January to May, it was found that captan significantly reduced leaf spot disease on Dabreak, which is our most susceptible commercial variety. Captan was applied in a 7- to 10-day schedule at the rate of 4 pounds in 100 gallons of water, with a power sprayer at 150 pounds pressure. Near the end of the fruiting season large numbers of plants in test plots were observed for leaf spot infection and placed in the following categories: (1) no spots, (2) a few spots on old leaves, (3) many spots on old leaves and a few spots on young leaves, (4) many spots on old and young leaves, (5) many spots on all leaves, with defoliation. In Table 2 the amount of leaf spot on captan treated plants is compared with the amount on plants not sprayed. For example, at location 1, 95 per cent of the plants treated with captan were not spotted and only 5 per cent had a few spots on the older leaves. Among the control plants, 25 per cent showed

[1]Italic numbers in parentheses refer to Literature Cited, Page 18.

Table 2.—Percentages of captan treated and nontreated plants showing various classes of leaf spot infection

	Location 1		Location 2		Location 3	
Classes*	Captan	Control	Captan	Control	Captan	Control
1	95	0	0	0	0	0
2	5	71	100	68	96	28
3	0	25	0	31	4	44
4	0	4	0	1	0	26
5	0	0	0	0	0	2

*Infection classes as follows: 1, no spots; 2, a few spots on old leaves; 3, many spots on old leaves and a few spots on young leaves; 4, many spots on old and young leaves; 5, many spots on all leaves, with defoliation.

severe leaf spotting on old leaves and 4 per cent showed severe spotting on both old and young leaves. These data indicate essentially that the control plants were more severely infected than the captan treated plants.

At all locations leaf spot was most severe on plants that did not receive the fungicide. Although the condition was most striking at location 3, it was obvious that captan treated plants were less infected at all locations.

Ziram (Zerlate) was also shown to control leaf spot when applied at the rate of 4 pounds in 100 gallons of water in a 7- to 10-day schedule from July to October. Although no data were recorded, the difference in severity of infection between treated and unsprayed plants was outstandingly obvious.

Crown Rot

During recent years a serious disease has become rampant in summer plant beds (*1, 2, 3, 4, 10, 12*). It is caused by the fungus *Colletotrichum fragariae*, which attacks primarily the strawberry plant crowns. Runners

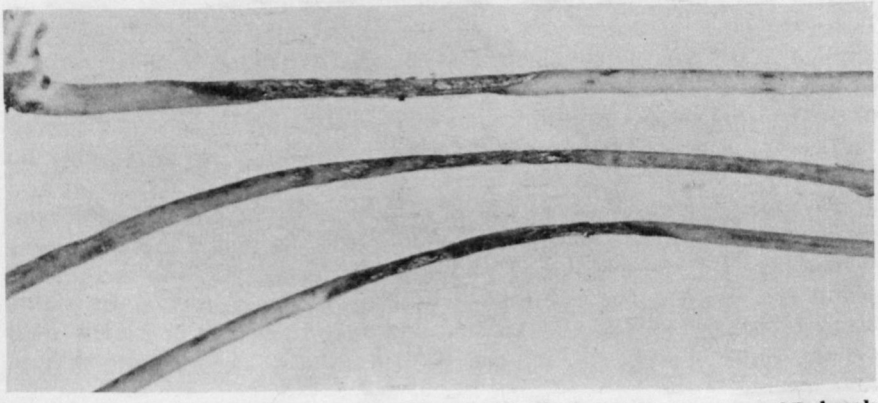

FIG. 2.—Infected areas caused by Colletotrichum fragariae on the runners of Dabreak.

FIG. 3.—Dabreak plants killed by Colletotrichum fragariae in May.

are also affected, in which case they may become totally blackened. In some instances only small sections of runners are blackened (Fig. 2) but runners are girdled so that the newly formed plant is pinched off before it can root and become established.

Essentially, the fungus enters the plant at the soil line and grows into the crown. It ramifies throughout the crown, killing the plant tissue so that the plant is unable to take up water from the soil. At this point the plant wilts rather suddenly (Fig. 3) as if it were broken off at ground level. Cross sections cut through the crowns (Fig. 4) revealed a reddish brown discoloration.

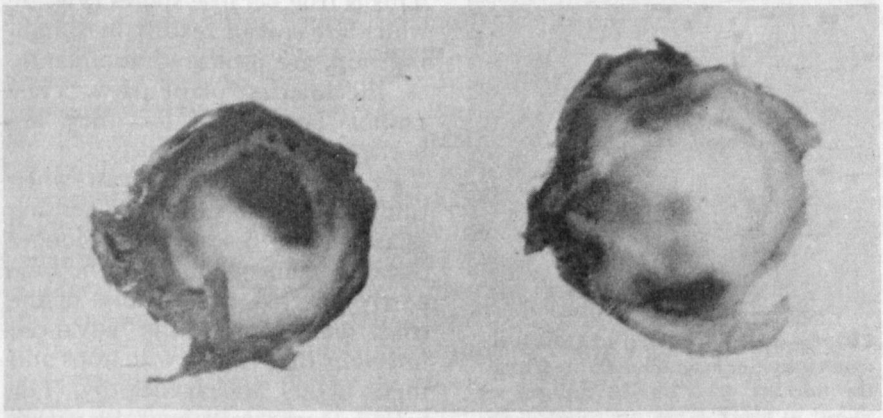

FIG. 4.—Cross sections cut through the crowns of Dabreak plants, showing the discolored areas of infection caused by Colletotrichum fragariae.

Both Headliner and Dabreak varieties were susceptible to crown rot under artificial conditions; however, the latter was more susceptible. In Table 3 the effect the fungus has on four varieties is shown. In this test healthy, vigorously growing plants were inoculated artifically in the greenhouse. In a series of three tests, plants grown in steamed soil in pots and considered free of the fungus were transferred to 6-inch pots containing steamed soil in which the fungus was thoroughly mixed. Two control plants of each variety were grown in steamed soil without inoculum. All were placed in a moist atmosphere at 86° F. for three days, then removed to a greenhouse bench where temperatures averaged 80° F. The per cent of dead plants was recorded (Table 3) 20 days after the tests were started. None of the control plants were infected after 20 days.

Table 3.—The per cent of plants killed by C. fragariae when artifically inoculated in the greenhouse

Variety	No. plants tested	Per cent killed after 20 days
Headliner	12	42
Klonmore	16	87
Marion Bell	12	83
Konvoy	12	91
Dabreak	23	85

Even though the disease has been sporadic, growers have had infection in plant beds to some degree during the past five or six summers. Warm, wet conditions favor the development of the disease, which usually starts in lower or less well drained areas of the field. Spread is rapid once infection sets in, particularly when daily showers occur. This is true because spores (Fig. 5), which are spread readily by splashing rain, are produced abundantly on the infected plant parts. They cannot be blown, for they are borne in a sticky substance.

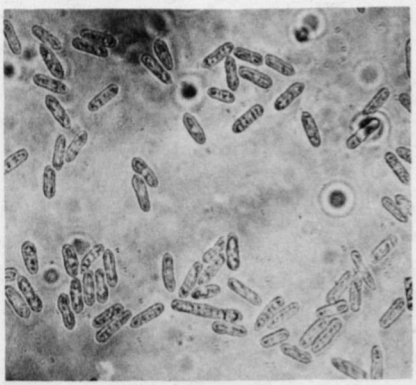

FIG. 5.—Spores (conidia) of Colletotrichum fragariae magnified 900 times from the infected areas on the runners as shown in Fig. 2. They are splashed by rain to healthy plant parts where they cause additional infection.

By November or at least when cold weather begins, the wilting phase of the disease is no longer obvious. Some plants may become partly infected, but because of the cold temperatures the advanced infection that causes wilt stops and these plants appear healthy. The fungus then carries over the winter within the plants. Experiments

FIG. 6.—An area in a summer bed where Colletotrichum fragariae had killed the Dabreak plants.

with artificially inoculated plants have shown that the fungus can be carried in plant crowns for 30 weeks at 40° F. When the plants were placed at 80° F. they died within a week. It is advisable, therefore, that a grower not use plants that border infected areas (Fig. 6), in order to decrease the chance of carrying along the infection to the next summer. Experiments have shown that the disease does not live over from summer to summer in the soil; in fact, healthy Dabreak plants did not become infected when set in soil that had been infested three months previously. Interviews with growers who have had to obtain a new plant source because they lost their stock during the summer from the crown rot fungus, indicated that since the change was made they had not had the disease reoccur. Growers who have had a considerably large problem with the disease are advised rather strongly to destroy their plant source and replace it with healthy plants.

Zerlate was tested as a control for crown rot for several years. The results were somewhat erratic. Perhaps improper timing of applications and extreme wet weather conditions which came immediately after treatment could have accounted for some of the poor results. However, Du-ter (47.5% Triphenyl tin hydroxide, Thompson-Hayward Chemical Co.) was much more effective than Zerlate in a field test in 1966 (*1*). Although this material has been used in only one test thus far, it appears to be a very promising one for the control of the disease. Test plots 10 feet long (Fig. 7) were planted with healthy Dabreak plants. Two plants in each plot were inoculated in the crown with the fungus. During July, August, September, and October the fungicides were ap-

FIG. 7.—The plants on the left had been treated with Du-ter; those on the right had not been sprayed.

plied in a 7-day spray schedule at 5 pounds of Zerlate and 2.5 pounds of Du-ter, respectively, in 100 gallons of water. Plants not sprayed were used as a control. On October 30, the number of living plants in each plot were counted and then dissected to determine the per cent crown rot (Table 4).

Table 4.—The total number of plants harvested and the per cent crown rot in Zerlate, Du-ter, and control plots

Treatment	No. plants	Per cent rot
Zerlate	74	14
Du-ter	215	4
Control	11	76

Because the work with Du-ter is in the preliminary stages, it cannot be recommended for use on strawberries. It must be remembered also that the Pure Food and Drug Administration must label any chemicals before they can be used on plants that produce products for human consumption. Du-ter has no such label for strawberries at this time.

Fruit Rot

The most destructive fruit rot disease of strawberries in the field is gray mold (Fig 8), which is also caused by a fungus (*Botrytis cinerea*). The disease is not restricted to the fruit but can attack any of the above-ground parts of the plant. However, it is primarily a fruit disease. The rot, which varies in severity from year to year depending on the weather conditions, is most severe when southeast winds prevail. Many growers do not know why this is true, but they have learned by experience that this is the case. Actually, the southeast winds bring moisture from the lake areas just southeast of the commercial belt. During the time of prolonged high humidity and rain the fungus has ideal conditions for development.

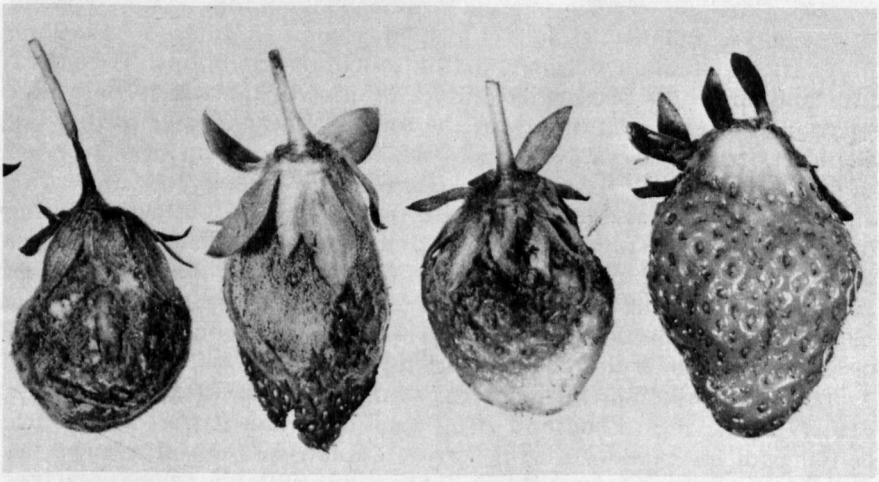

FIG. 8.—The three berries on the left are infected with gray mold caused by Botrytis cinerea; the other berry is healthy.

To demonstrate the effect of excessive moisture on Headliner berries a sprinkler system was used in the field to induce rot. This system put out sufficient water to keep the plants thoroughly wet during a 3- to 4-day period without flooding. Table 5 indicates that over the 2-week period

Table 5.—Mean per cent rot of Headliner berries under the field sprinkler system vs. the per cent rot of berries not sprinkled

Date	Not treated, not sprinkled	Captan, sprinkled	Not treated, sprinkled
4-20	0.8	1.3	6.8
4-28	4.4	3.8	16.8
5-5	0.8	3.3	24.2
Means	2.0	2.8	15.9
L.S.D. 1%	13.50		
5%	9.28		

the mean per cent rot was significantly higher when the plants were wet. These data also show that captan controlled the rot disease significantly. Note the increase in rot from 7 to 24 per cent during the test period.

Fruit infected with this disease become covered with masses of spores which give them a gray appearance. These spores can be blown readily through the air or passed from one plant to the next by pickers who touch the infected fruit on one plant and spread the spores that stick to their hands onto other plants down the row. A common practice is to throw the rotted fruit into the middles of the rows. These infected fruit produce a source of inoculum that can be of particular significance in helping to spread the disease.

The fungus lives over in the soil from one fruiting season to the next in the form of sclerotia. This term is given to the "resting form" of the fungus. They are black, irregular-shaped bodies ranging up to about 3/16 inch in diameter. They consist of a compact mass of mycelium (threads) that remain dormant in the soil until conditions of temperature and moisture become favorable for growth, at which time they "germinate." The fungus lives in the soil from year to year so that one would expect to have a build-up of the disease inoculum over a period of years. "New soil" presents less problem. Frequently, in the spring about the time blossoms appear the fungus can be observed fruiting (producing spores) on dead or senescent leaves at the base of plants just as it does on the fruit. This infection comes from the sclerotia that are in the soil. The spores are then blown or are splashed onto the blossoms and lodge in the floral parts to cause a blossom blight (Fig. 9) or later to start the fruit infection (Fig. 10) cycle.

Fungicides recommended for rot control are captan and thiram (*5, 6, 7, 14*). The Pure Food and Drug Administration has set a tolerance of 100 ppm for captan on strawberries. Captan sprayed on strawberries at 3.8 pounds active material or 7.6 pounds formulated material per

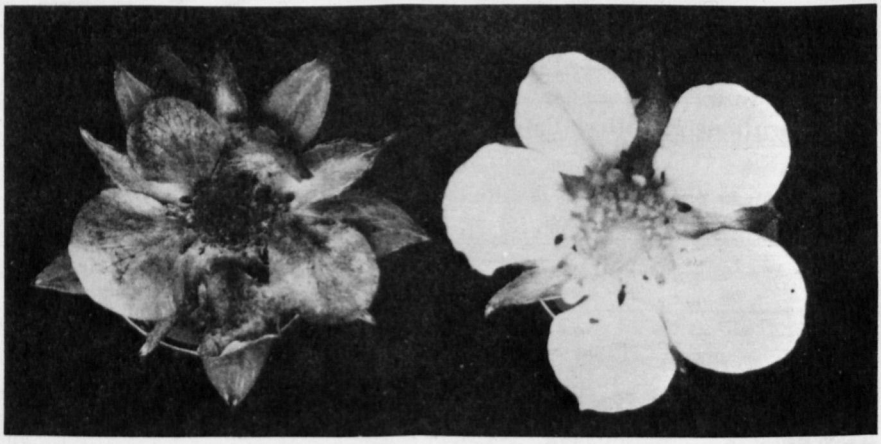

FIG. 9—The infected Headliner flower on the left was inoculated artificially with Botrytis cinerea.

FIG. 10.—Rotted fruit caused by Botrytis cinerea on Headliner plants in the field. Even the green berries are infected.

acre will not exceed this tolerance. Captan is sold under the commercial names Orthocide 50 Wettable (50 per cent) and Stauffer Captan Garden Spray (50 per cent). It should be applied to strawberry plants starting about the middle of February in a 7- to 10-day spray schedule.

Thiram (DuPont's Thylate) is packaged as a 65 per cent wettable powder and has a 7 ppm tolerance. This tolerance will not be exceeded if thiram is applied at the rate of 3.25 pounds of active material or 5 pounds of the formulation per acre three days or longer in advance of harvest. Berries treated with thiram and harvested less than three days later must be washed. This means that the material was intended to be used on berries for processing and not on fruit for fresh market use. Thiram should be used in a 7- to 10-day spray schedule.

Read the labels carefully for the use of both captan and thiram on strawberries before spraying with either fungicide.

Fungicide spray programs in which captan and thiram were used were carried out over a number of fruiting seasons. An example of the effectiveness of captan and thiram as compared with one of the poorer fungicides is shown in Table 6. The data indicate the amount of rot

Table 6.—Mean per cent rot of fruit and yields in 24-pint crates per acre of the Headliner and Konvoy varieties sprayed with captan and thiram in the field

	Mean per cent rot		Mean yield	
Fungicide	Headliner	Konvoy	Headliner	Konvoy
Captan	7.3	22.0	47.3	30.8
Thiram	7.9	21.0	44.8	28.5
Control	38.6	86.0	32.2	15.8
L.S.D. 5%	10.6	42.7	11.1	5.7
1%	14.4	58.7	18.2	7.8

that occurred under good conditions for the development of the fungus, and the average yields in crates per acre. The yield data shown were not for the entire season but were recorded during a consecutive number of days on which rot was most prevalent. The yields in general reflected the percentage of rot that occurred in any one treatment, so that when the percentage of rot was high, the yields were low and vice versa. The fungicides were started when blossoms began to appear in the latter part of February. They were applied with a power sprayer at 150 pounds pressure with the spray directed to get good coverage under the plants as well as on top. For maximum control of fruit rot, power sprayers should be used so that the fungicide can cover the areas under the plant where rot is most likely to develop. Low pressure sprayers directed down on the plants flatten the foliage and prevent the fungicide from getting to the areas desired.

Nematodes

Nematodes are round, slender, thread-like worms called eel worms which feed on the roots and sometimes the leaf buds or crowns of plants. The most destructive soil-borne nematode found associated with strawberries was root knot (*Meloidogyne hapla*), which was isolated commonly from Louisiana soils wherever strawberries were grown. Although on plants such as tomato the galls formed by these worms are very large and strikingly obvious, they are small and insignificant on strawberry roots. However, their effect on the strawberry plant can be very injurious (Fig. 11).

A survey of the soil-borne nematodes in the commercial strawberry areas of Louisiana showed that 25 genera of nematodes were present in soil around strawberry roots. Of these, seven genera were known to

FIG. 11.—The row on the right was treated with nematocide in June and set with Klonmore plants in July. The row on the left was not treated.

be plant parasites and three were suspected parasites. A list of the nematodes is given in a previous publication (*9*). All of these nematodes were not studied to determine their effect on strawberry plants. Greenhouse experiments showed, however, that root knot propagated readily on roots of the Klonmore variety, with severe root damage resulting.

Table 7 shows how the population of root knot nematodes can build up in strawberry soils. The figure in the table represents an extremely high number of nematodes to be taken from a pint of soil. Although populations in the field were not found to be of this magnitude, the numbers were considered high enough to do significant damage. Soil fumigation can reduce these populations to practically zero and significantly improve yields of plants. An example of nematode control when Dowfume W-85 (ethylene dibromide) was injected into soil at the rate of 3 gallons per acre is shown in Table 8.

Fruit yields of plants grown in the treated soil were significantly higher than yields of plants grown in the nontreated soil. Table 9 demonstrates these differences.

Table 7.—The mean[a] number of root knot nematodes added to the soil of pots with strawberry plants and the number per pot[b] 190 days later

Treatment	Number added	Number per pot 190 days later
1	0	0
2	462	22,420

[a] Mean of 4 pots.
[b] Estimated on the basis of the number of nematodes obtained in 1-pint soil sample from each pot. Only larvae were counted.

Table 8.—Mean number of root knot nematodes from pint soil samples 44 and 155 days after treatment

Fumigated		Not fumigated	
44 days later	155 days later	44 days later	155 days later
0	4	132	2922
0	6	232	1582
0	20	168	2514
0	2	196	1728
L.S.D. 5%	1183		
1%	1586		

Table 9.—Mean yields in 24-pint crates per acre of Klonmore and L-27 plants grown in treated and nontreated soil

Variety and treatment	Yield in crates per acre
Klonmore in treated soil	211.13
Klonmore in nontreated soil	137.14
L-27 in treated soil	412.51
L-27 in nontreated soil	249.52

The materials to use for nematode control are Dowfume W-85 (ethylene dibromide) at 3 gallons per acre, Telone (dichloropropenes and related C-3 compounds) at 7 gallons per acre, both sold by the Dow Chemical Co., and D-D Mixture (dichloropropane-dichloropropene) at 10 gallons per acre, sold by the Shell Co.

An apparatus for soil fumigation can be made with not too much difficulty. Essentially it consists of a gravity flow system mounted on the rear of a tractor. A tube extends from the tank to and behind a harrow blade. The grower would have to be able to adjust the system so that he could release about 3 pounds of Dowfume W-85 per acre at a cost of about $15. The soil should be treated during October when soil temperatures are still not below 60° F. and at least 10 days before laying plastic or planting. For information about applicators, contact your county agent.

Virus Diseases

Of the diseases reviewed herein, those caused by viruses are the least understood by growers. Perhaps the reason for this is that infected commercial varieties show no visible appearance of being diseased. There is one exception, however: aster yellows virus causes a definite

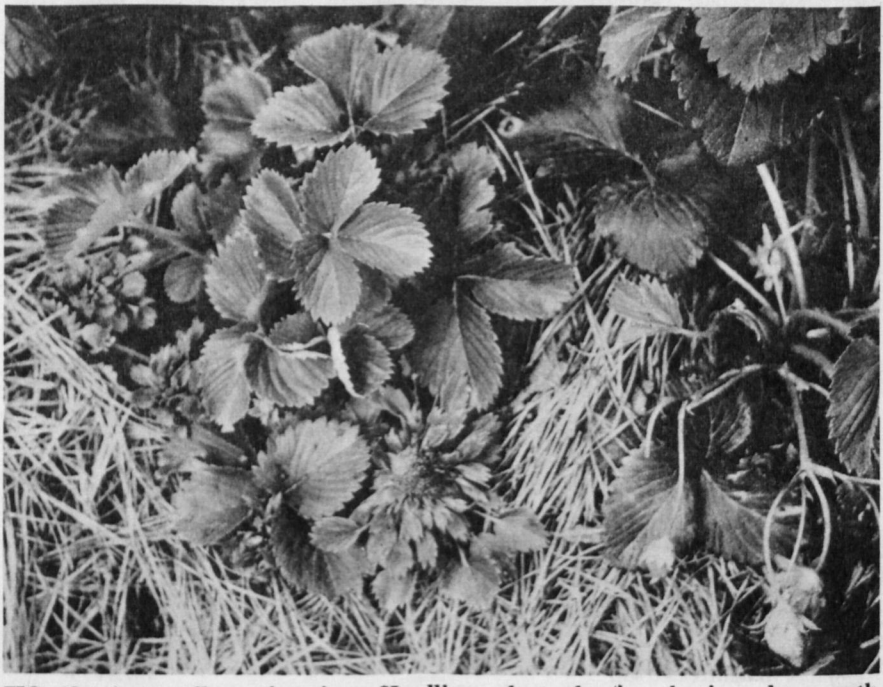

FIG. 12.—Aster yellows virus in a Headliner plant, showing the irregular growth pattern (lower center). This is the only virus that produces visible symptoms on commercial varieties in Louisiana.

irregular growth pattern in strawberries (Fig. 12), but is of no importance. We say, then, that virus infection in strawberry plants is latent; that is, the plants carry the virus but exhibit no visible symptoms. Even the researcher cannot tell whether any particular commercial plant is virus infected except by a special technique in which the suspected infected plant is grafted to a wild strawberry plant that will show symptoms. Although the commercial plants appear healthy, the viruses have a definite detrimental effect on them. Infected plants produce fewer plants during the summer and are less productive at fruiting time.

In a survey (Table 10) made throughout the strawberry belt it was found that in every planting tested the percentage of virus infection was extremely high. Samples were taken from Ponchatoula, Hammond, Amite, Albany, Whitehall, and Livingston. It is not known how long the strawberry viruses have been in Louisiana, but the important fact is that they are here now and the percentage of infection is extremely high. The common viruses known to occur in Louisiana are aster yellows, vein banding, mottle, and latent A viruses *(11, 13)*. Another virus or complex that produces a mottle-type symptom has also been described *(8)*.

It should be pointed out here that viruses are spread by aphids (plant lice). The insects feed on a diseased plant and then go to other plants to feed. The viruses are transmitted during this feeding process. When aphids are active the spread of virus can be very rapid. For example, first- to ten-year seedlings at the Louisiana State University Experiment Station were indexed for virus. It was found that even the seedlings that were set in the field for the first time were from 75 to 100 per cent virus infected.

Because the viruses are not transmitted mechanically, there is no need to be concerned about transmitting them when handling the plants during transplanting.

As mentioned previously, the strawberry viruses reduce plant and berry production. When virus-free Headliner plants were compared with infected Headliner plants it was found that plant production was reduced as much as 30 per cent and fruit yield nearly 20 per cent.

The control of virus diseases can be accomplished by the use of

Table 10.—The occurrence of mottle virus and vein banding virus in Louisiana strawberry varieties

Variety	No. samples tested	No. samples containing virus		Per cent infection
		Mottle	Vein banding	
Headliner	132	103	8	84
Dabreak	23	22	0	95
Klondike	36	31	3	95
Klonmore	56	45	6	91
Marion Bell	31	26	1	87
Konvoy	12	4	3	58

disease-free plants grown in an isolated area. This has been done successfully in other states where there are only a few growers and they have very large plantings. Berry farms there are separated by many miles, which means that they are isolated enough that insects cannot carry the infection to them. In Louisiana we have many small farms in very close range to each other, so that very few growers are in isolation. This means that a farmer in this congested area cannot have disease-free plants perhaps for even a year.

Literature Cited

1. Carver, R. B. 1967. Control of the crown-rot fungus *Colletotrichum fragariae* in strawberries. Thesis. Louisiana State Univ. 41 pp.
2. Carver, R. B., and N. L. Horn. 1966. Overwintering of the crown-rot fungus *Colletotrichum fragariae*. Phytopathology 56: 873.
3. Carver, R. G. 1959. Studies on *Colletotrichum fragariae* in relation to summer dying of strawberries. Thesis. Louisiana State Univ. 55 pp.
4. Carver, R. G., and N. L. Horn. 1960. Summer killing of strawberry plants caused by *Colletotrichum fragariae*. Phytopathology 50: 575.
5. Horn, N. L. 1952. Strawberry fungicide screening tests. Plant Dis. Reptr. 36: 309-310.
6. Horn, N. L. 1956. A method for testing fungicides in the laboratory for controlling Botrytis fruit rot of strawberries. Phytopathology 46: 15.
7. Horn, N. L. 1960. Spraying to control strawberry fruit rot. La. Agr. 3: 14-15.
8. Horn, N. L. 1965. A mottle-type symptom produced in *Fragaria virginiana* by virus obtained from commercial strawberries. Phytopathology 55: 1062.
9. Horn, N. L., et al. 1956. The relation of nematodes to strawberry culture in Louisiana. Plant Dis. Reptr. 40: 790-797.
10. Horn, N. L., and R. G. Carver. 1962. Anthracnose and powdery mildew on strawberry plants in Louisiana. Plant Dis. Reptr. 46: 951-952.
11. Horn, N. L., and R. G. Carver. 1962. Effect of 3 viruses on plant production and yields of strawberries. Plant Dis. Reptr. 46: 762-765.
12. Horn, N. L., and R. G. Carver. 1963. A new crown-rot of strawberry plants caused by *Colletotrichum fragariae*. Phytopathology 53: 768-770.
13. Horn, N. L., and R. G. Carver. 1966. How viruses affect Louisiana strawberries. La. Agr. 9: 10-11.
14. Horn, N. L., and P. L. Hawthorne. 1961. Control of Botrytis rot of strawberries. La. Agr. Expt. Bull. 547.
15. Plakidas, A. G. 1934. Control of strawberry leaf blights in Louisiana. La. Agr. Expt. Bull. 252.